



UNITED STATES AIR FORCE RESEARCH LABORATORY

INTERLABORATORY STUDY (ILS) FOR F 428-83, THE STANDARD TEST METHOD FOR INTENSITY OF SCRATCHES ON AEROSPACE GLASS ENCLOSURES

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JANUARY 2003

20030725 129

INTERIM REPORT FOR THE PERIOD 1 JUNE 2001 TO 1 JANUARY 2002

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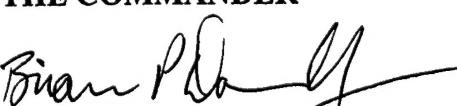
TECHNICAL REVIEW AND APPROVAL

AFRL-HE-WP-TR-2003-0012

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER


BRIAN P. DONNELLY, Lt Col, USAF
Deputy Chief, Crew System Interface Division
Air Force Research Laboratory

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED	
	January 2003	INTERIM - 1 June 2001 to 1 January 2002	
4. TITLE AND SUBTITLE			5. FUNDING NUMBERS
Interlaboratory Study (ILS) for F 428-83, The Standard Test Method for Intensity of Scratches on Aerospace Glass Enclosures			F33615-98-D-6000 PE: 62202F PR: 7184 TA: 11 WU: 16
6. AUTHOR(S)			
Alan R. Pinkus* Martha A. Hausmann**			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)			8. PERFORMING ORGANIZATION
* * Sytronics, Inc. 4433 Dayton-Xenia Road Dayton OH 45432			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSORING/MONITORING
*Air Force Research Laboratory Human Effectiveness Directorate Crew System Interface Division Air Force Materiel Command Wright-Patterson AFB OH 45433-7022			AFRL-HE-WP-TR-2003-0012
11. SUPPLEMENTARY NOTES			
12a. DISTRIBUTION/AVAILABILITY STATEMENT		12b. DISTRIBUTION CODE	
Approved for public release; distribution is unlimited.			
13. ABSTRACT (Maximum 200 words)			
Scratches exist on all glass surfaces. Usually, cleaning procedures cause very fine scratches that are not visible when looking through the glass. Visible scratches may be distracting to an observer looking through a transparent aerospace enclosure. Therefore, a procedure to define scratches is useful. A visual comparison is made between a set of graded scratch standards and a scratch on the glass transparency to determine its relative intensity. A visual standard is used because it is not practical to measure the dimensions of the fine scratches.			
14. SUBJECT TERMS			15. NUMBER OF PAGES
scratches, transparent glass, comparison, standards			46
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

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ACKNOWLEDGMENTS

The authors recognize the significant contribution of Mr. Sam T. Bailey of Davidson Optronics, Inc., W. Covina, California, for developing and allowing the use of their glass adjuncts during the course of the standard development and conduct of the interlaboratory study (ILS). Additionally, Mr. Tom Whitney, of the University of Dayton Research Institute, who provided the scratched glass samples that were instrumental in the conduct of the ILS. We also thank the organizations that participated in the ILS. Lastly, we gratefully acknowledge the excellent statistical analyses provided by Mr. Charles. D. Goodyear.

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1. TITLE

INTERLABORATORY STUDY (ILS) FOR F 428-83, THE STANDARD TEST METHOD FOR INTENSITY OF SCRATCHES ON AEROSPACE GLASS ENCLOSURES

Committee F-7 on Aerospace and Aircraft Enclosures

Subcommittee F-7.08 on Transparent Enclosures and Materials

RR F07-1008

2. INTRODUCTION

The American Society for Testing and Materials (ASTM) develops and publishes standardized test methods. Each test method requires a precision and bias statement so organizations that apply the method know its inherent reproducibility (between-laboratory variability) and repeatability (within-laboratory variability). Reproducibility and repeatability for this test method were determined by conducting an interlaboratory study (ILS) as outlined in ASTM E 691. This report, which conforms to the ILS reporting format required by ASTM, describes the study that was conducted for ASTM test standard F 428-83, Intensity of Scratches on Aerospace Glass Enclosures.

Scratches exist on all glass surfaces. Usually, cleaning procedures cause very fine scratches that are not visible when looking through the glass. Visible scratches may be distracting to an observer looking through a transparent aerospace enclosure. Therefore, a procedure to define scratches is useful. A visual comparison is made between a set of graded scratch standards (adjuncts) and a scratch on the glass transparency to determine its relative intensity. A visual standard is used because it is not practical to measure the dimensions of the fine scratches.

3. TEST METHOD

See ASTM F 428-83, Standard Test Method for Intensity of Scratches on Aerospace Glass Enclosures

4. LIST OF PARTICIPATING LABORATORIES

AFRL/HECV
2255 H St. Room 300
Wright-Patterson AFB, OH 45433-7022

Sierracin/Sylmar Corp.
12780 San Fernando Rd.
Sylmar, CA 91342

PPG Industries, Inc.
1719 E. Highway 72
Huntsville, AL 35811

Pilkington Aerospace
12122 Western Ave.
Garden Grove, CA 92841

University of Dayton Research Institute
300 College Park Ave.
Dayton, OH 45469-0110

Texstars, Inc.
802 Ave J East
Grand Prairie, TX 75053

Boeing Co.
800 N. 6th St., 10.20 Bldg. Lobby
Renton, WA 98055

5. INTERLABORATORY TEST PROGRAM INSTRUCTIONS

Cover letter for test instructions to participating laboratories:

Subject: ASTM Interlaboratory Study (ILS) for Measuring Intensity of Scratches on Aerospace Enclosures
To: Participating Organization
From: Alan Pinkus
AFRL/HECV, 2255 H St Room 300
Wright-Patterson AFB OH 45433-7022

Dear Colleague,

As part of ASTM Committee 7.08 standards writing activity, we are conducting an ILS in order to ascertain the precision of Standard Test Method for Intensity of Scratches on Aerospace Enclosures, F 428-83. Since this method has a numerical result, it requires a precision statement. After the ILS, F 428-83 will be revised to include a precision statement.

Your participation in this study is greatly appreciated. No data will be released with any company or individual identification labels. The data in the ILS report to ASTM are given generic labels and the final precision statement uses only summary statistics as outlined in ASTM E 691 and ASTM E 177. If there are any questions, please do not hesitate to contact Alan Pinkus (937-255-8767).

Sincerely,
Alan Pinkus, Ph.D.

6 Attachments:

1. ASTM F 428-83 Standard Test Method
2. 6-Piece Set of Aerospace Scratch Standards for Glass
3. 12 Glass Scratch Samples
4. Test Instructions
5. Data Sheet
6. Return Address Label

Test Instructions:

Your task is to determine the scratch intensity levels of different scratch samples.

1. Complete the background information on the data sheet.
2. There are 12 glass scratch samples and 6 scratch test standards. The 12 glass scratch samples to be compared to the scratch test standards and rated are labeled A through L. The 6 scratch test samples are labeled 3 through 8 and are stored in the brown wooden box labeled Aerospace Scratch Standards for Glass. Caution: these ASTM standards cost \$1500 per set.
3. Beginning with **trial #1** on the data sheet, select the designated **scratch sample** (A through L) and place in an angled position to allow for optimum visual definition of the scratch. *Please handle the scratch samples and standards by the edges only to avoid getting fingerprints on them.* If they become dirty, carefully wipe using the supplied cloth. Since they are laminated, Do Not immerse in any liquid.) The light level required for judgment is a minimum of 80 lux. Natural or artificial light may be used. Determine the

rating of the scratch sample by comparing it to the scratch test standards by placing the test standards next to the scratch sample, one at a time. Select the test standard (3 through 8) that most closely matches the scratch sample. Disregard scratch lengths. Record the scratch level number in the **rating** column located on the data sheet. Repeat this procedure for all 60 trials.

4. Return your data sheet, the 12 glass scratch samples and the 6 scratch test standards to Alan Pinkus, AFRL/HECV, 2255 H St, Room 300, Wright-Patterson AFB OH 45433-7022. Note: The packaging has been designed for reuse for both your convenience and to assure full protection of the delicate test pieces. A return address label has been included. Please insure the contents for \$1500.

Sample Data Sheet:

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials: _____					
Date: _____					
Organization: _____					
Observer #: _____					
Trial #	Scratch Sample	Rating	Trial #	Scratch Sample	Rating
1			31		
2			32		
3			33		
4			34		
5			35		
6			36		
7			37		
8			38		
9			39		
10			40		
11			41		
12			42		
13			43		
14			44		
15			45		
16			46		
17			47		
18			48		
19			49		
20			50		
21			51		
22			52		
23			53		
24			54		
25			55		
26			56		
27			57		
28			58		
29			59		
30			60		

6. DATA REPORT FORMS

See Appendix A

7. STATISTICAL DATA SUMMARY

Thirty-one trained observers rated 12 glass scratches. Each scratch was rated five times by each observer. The 60 trials for each observer were randomized with the constraint that there be at least 10 trials between replications of the same scratch. Observers were provided adjuncts that had scratch ratings of 3, 4, ..., 8 (3 is the thinnest and 8 is the thickest). For an individual trial, the observer would place one of the 12 scratches next to the adjuncts and determine the closest match. Figures 2a & 2b, show the number of trials for each observer and scratch having a particular scratch rating. Table 1 shows the judged rank-order of the glass scratch samples. Figure 1 contains the percent of the 155 total trials (31 observers x 5 replications) for each scratch having a particular scratch rating.

Table 1. Rank-order of glass scratch samples.

Scratch	Mean Rating (N = 155)
J	3.0
D	3.3
L	4.1
H	4.2
A	4.2
I	4.6
B	4.7
F	5.3
E	6.4
G	7.8
K	7.9
C	8.0

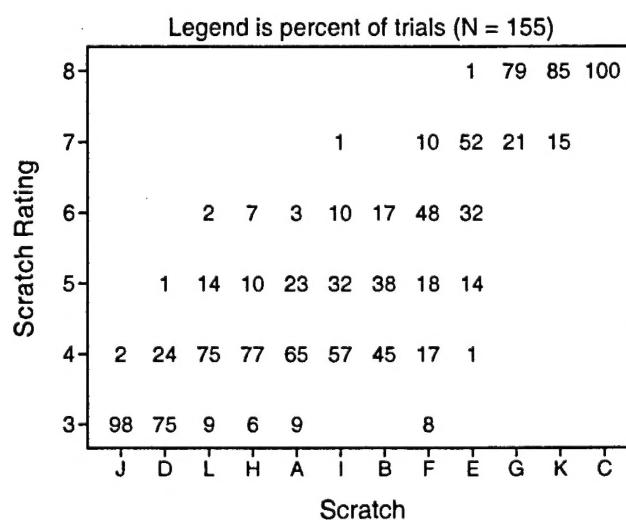


Figure 1. Percent of all trials for each scratch (N = 155) having a particular scratch rating.

Of interest is how consistently the observers rated each scratch for their 5 replications and how close scratch ratings were from one observer to another. For continuous variables, repeatability and reproducibility limits could be determined using the normal distribution where 95th percentiles for absolute difference in trials are estimated. The discrete ratings in this data does not lend itself to this type of analysis. Instead, the percent of all absolute differences in trials, both within and between observers, was calculated for each possible absolute difference (i.e., 0 to 5). Results are shown in Table 2. Cumulative percents are shown in Table 3.

Table 2. Mean rating across all observers and trials (N = 155) and percent of absolute difference in trials both within (N = 31 observers * 10 paired reps per observer = 310) and between (N = 31 observers * (5 reps * 150 other trials)/2 = 11625) observers.

Scratch	Mean Rating (N = 155)	Percent of Absolute Difference in Trials									
		Within Observers (N = 310)				Between Observers (N = 11625)					
		0	1	2	3	0	1	2	3	4	
J	3.0	96.1	3.9			96.2	3.8				
D	3.3	92.6	7.1	0.3		61.6	37.4	1.0			
L	4.1	81.3	15.5	3.2		58.0	36.1	5.6	0.4		
H	4.2	88.1	8.4	3.5		59.9	26.9	12.4	0.9		
A	4.2	83.2	12.3	4.5		47.5	44.4	7.7	0.5		
I	4.6	73.5	21.9	4.5		42.4	44.0	12.1	1.5		
B	4.7	78.1	20.0	1.9		36.2	48.2	15.6			
F	5.3	63.2	26.8	9.7	0.3	29.1	35.6	22.8	11.0	1.5	
E	6.4	71.0	25.5	3.2	0.3	38.3	44.2	15.8	1.6	0.02	
G	7.8	92.3	7.7			66.3	33.7				
K	7.9	96.8	3.2			74.0	26.0				
C	8.0	100				100					

Table 3. Mean rating across all observers and trials (N = 155) and cumulative percent of absolute difference in trials both within (N = 31 observers * 10 paired reps per observer = 310) and between (N = 31 observers * (5 reps * 150 other trials)/2 = 11625) observers.

Scratch	Mean Rating (N = 155)	Cumulative Percent of Absolute Difference in Trials									
		Within Observers (N = 310)				Between Observers (N = 11625)					
		0	1	2	3	0	1	2	3	4	
J	3.0	96.1	100			96.2	100				
D	3.3	92.6	99.7	100		61.6	99.0	100			
L	4.1	81.3	96.8	100		58.0	94.1	99.6	100		
H	4.2	88.1	96.5	100		59.9	86.7	99.1	100		
A	4.2	83.2	95.5	100		47.5	91.8	99.5	100		
I	4.6	73.5	95.5	100		42.4	86.4	98.5	100		
B	4.7	78.1	98.1	100		36.2	84.4	100			
F	5.3	63.2	90.0	99.7	100	29.1	64.7	87.5	98.5	100	
E	6.4	71.0	96.5	99.7	100	38.3	82.6	98.4	99.98	100	
G	7.8	92.3	100			66.3	100				
K	7.9	96.8	100			74.0	100				
C	8.0	100				100					

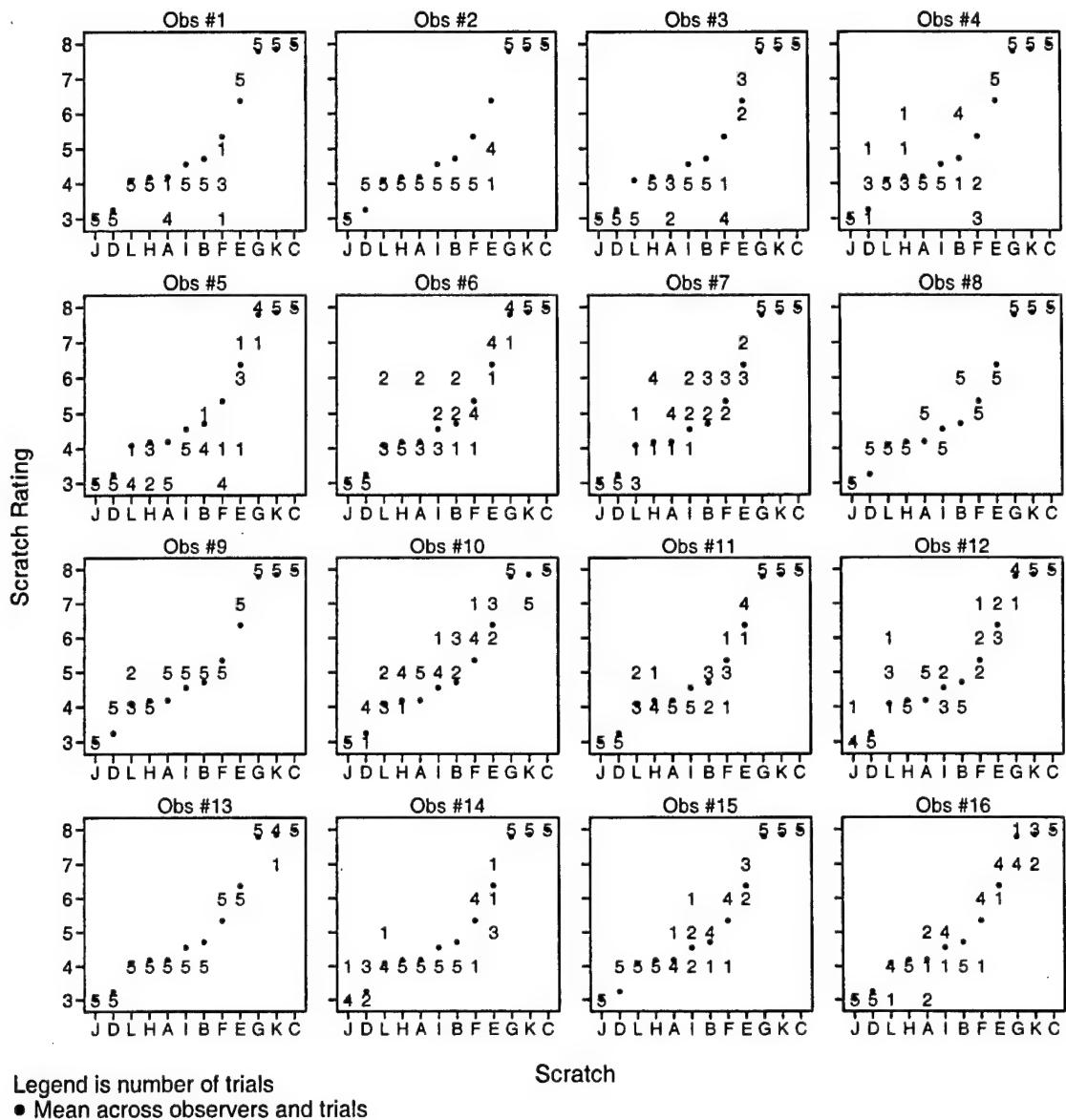


Figure 2a. Number of trials for observers 1-16 and scratch ($N = 5$) having a particular scratch rating.

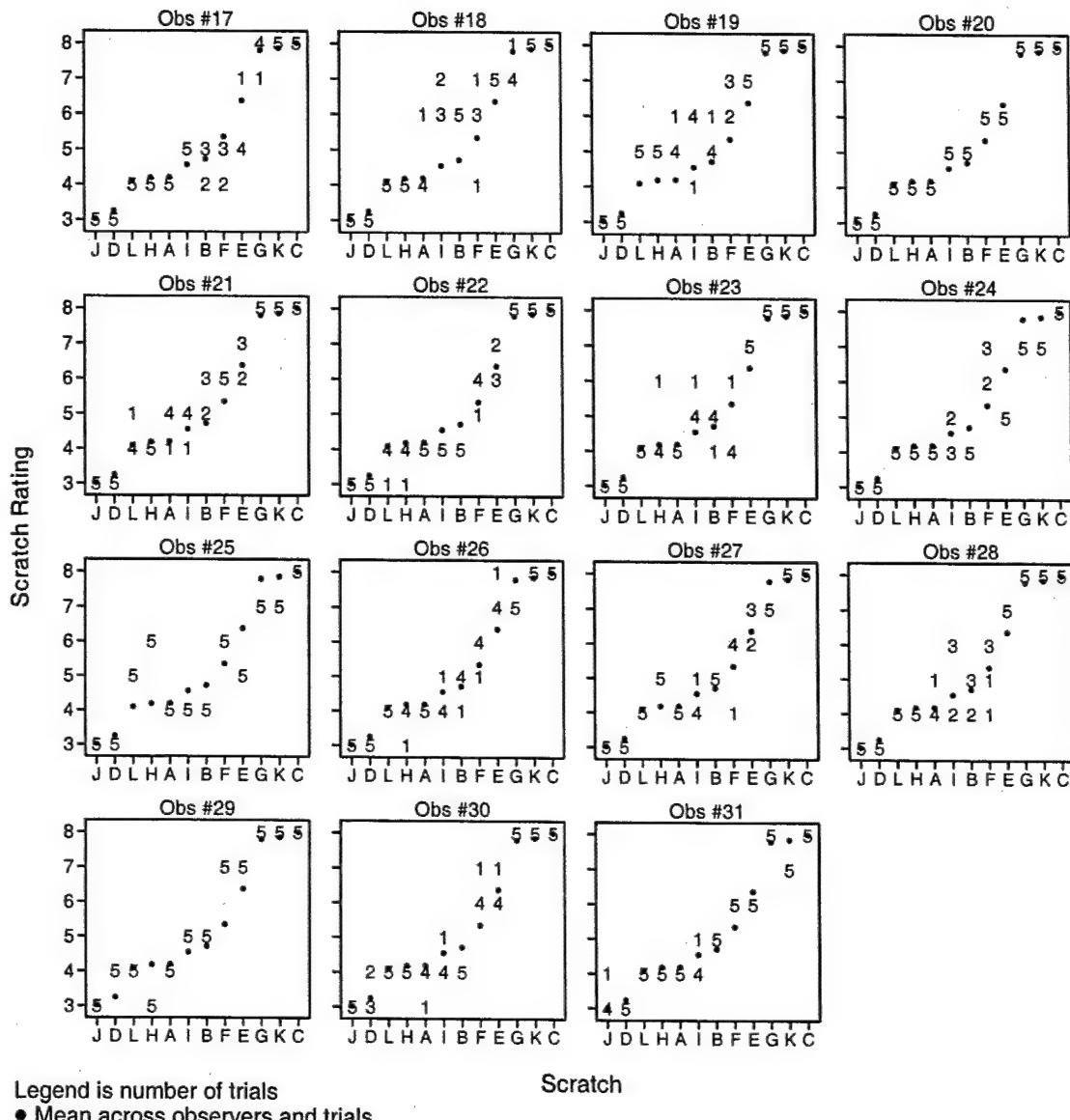


Figure 2b. Number of trials for observers 17-31 and scratch (N = 5) having a particular scratch rating.

8. RESEARCH REPORT SUMMARY

Standard repeatability and reproducibility analyses (ASTM E 691) cannot be applied to these data since they are discrete instead of continuous. The cumulative percent of the absolute difference in trials data shown in Table 3 best delineate the within-laboratory (observer) and between-laboratory variability that may be expected for this test method.

9. PRECISION and BIAS

Precision - The repeatability of judging the intensity of a scratch within one scratch value, for the same observer, is 90% or better.

The reproducibility (between observers) of judging the intensity of a scratch within two scratch values is 87% or better.

Bias – The procedure in this test method has no bias because the scratch intensity is defined only in terms of the test method.

Note: A study was performed to determine equivalent relationships between glass and plastic scratch adjuncts. This empirically derived relationship can be used if needed when: (1) only glass adjuncts are available to judge the intensity of scratches in plastic, (2) only plastic adjuncts are available to judge the intensity of scratches in glass or (3) it is desirable to convert the between the glass and plastic scales. The data and conversion formula are presented but the precision was not determined. Please refer to Appendix B.

APPENDIX A

Data report forms:

ASTM Intensity of Scratches Interlaboratory Study Data Sheet										
Initials: _____			Observer #: 1							
Date: _____										
Organization: _____										
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating					
1	K	8	31	L	3/4					
2	G	8+	32	I	4					
3	A	3	33	D	3					
4	C	8	34	J	3-					
5	H	4	35	E	7					
6	B	4	36	F	3					
7	L	3/4	37	K	8					
8	D	3-	38	H	4					
9	I	4	39	B	4					
10	F	4	40	C	8					
11	J	3-	41	A	3					
12	E	7	42	G	8+					
13	K	8	43	I	4					
14	G	8+	44	L	3/4					
15	C	8+	45	D	3					
16	H	4	46	E	7					
17	B	4	47	J	3-					
18	L	3/4	48	K	8					
19	A	3	49	F	4					
20	D	3	50	H	4					
21	I	4	51	B	4					
22	J	3-	52	A	3					
23	E	7	53	G	8+					
24	F	5	54	I	4					
25	G	8+	55	C	8+					
26	K	8	56	D	3					
27	H	4	57	E	7					
28	B	4	58	L	3/4					
29	C	8	59	J	3-					
30	A	4	60	F	4					

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials: _____		Observer #: 2			
Date: _____					
Organization: _____					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	E	4	31	D	4
2	F	4	32	K	8
3	C	8+	33	J	3-
4	G	8+	34	B	4
5	H	4	35	L	3-4
6	D	4	36	E	5
7	I	4	37	C	8+
8	L	3-4	38	A	4
9	J	3-	39	G	8+
10	K	8	40	H	4
11	B	4	41	I	4
12	A	4	42	F	4
13	E	5	43	D	4
14	F	4	44	J	3-
15	C	8	45	B	4
16	G	8+	46	K	8
17	D	4	47	E	5
18	H	4	48	L	3-4
19	I	4	49	A	4
20	L	3-4	50	C	8+
21	K	8	51	H	4
22	J	3-	52	G	8+
23	B	4	53	F	4
24	A	4	54	I	4
25	E	5	55	J	3-
26	C	8	56	D	4
27	G	8+	57	B	4
28	F	4	58	K	8
29	H	4	59	L	3-4
30	I	4	60	A	4

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials: _____		Observer #: 3			
Date: _____					
Organization: _____					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	B	4	31	B	4
2	D	3	32	G	8
3	I	4	33	H	4
4	F	4	34	E	7
5	L	3	35	J	3
6	C	8	36	K	8
7	A	3	37	I	4
8	G	8	38	F	3
9	H	4	39	D	3
10	J	3	40	C	8
11	E	6	41	L	3
12	B	4	42	B	4
13	D	3	43	G	8
14	K	8	44	H	4
15	I	4	45	A	4
16	F	3	46	J	3
17	C	8	47	K	8
18	A	4	48	E	6
19	L	3	49	F	3
20	G	8	50	I	4
21	J	3	51	D	3
22	H	4	52	L	3
23	E	7	53	C	8
24	D	3	54	B	4
25	K	8	55	H	4
26	I	4	56	A	3
27	F	3	57	J	3
28	C	8	58	K	8
29	A	4	59	E	7
30	L	3	60	G	8

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 4			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	E	7	31	B	6
2	K	8	32	G	8
3	D	4	33	H	6
4	I	8 4	34	E	7
5	L	4	35	A	4
6	B	6	36	C	8
7	H	4	37	F	3
8	J	3	38	K	8
9	G	8	39	L	4
10	C	8	40	D	4
11	A	4	41	I	4
12	E	7	42	J	3
13	K	8	43	B	6
14	F	3	44	H	5
15	D	5	45	E	7
16	L	4	46	A	4
17	I	4	47	G	8
18	H	4	48	F	4
19	J	3	49	C	8
20	B	6	50	K	8
21	G	8	51	D	3
22	A	4	52	L	4
23	E	7	53	I	4
24	C	8	54	B	4
25	F	3	55	H	4
26	K	8	56	J	3
27	D	4	57	A	4
28	L	4	58	G	8
29	I	4	59	F	4
30	J	3	60	C	8

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials: _____			Observer #: 5		
Date: _____			Organization: _____		
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	I	4	31	B	4
2	H	3	32	K	8
3	L	3	33	E	6
4	F	3	34	J	3-
5	A	3	35	H	4
6	J	3-	36	D	3
7	G	8	37	C	8
8	B	5	38	F	3
9	K	8	39	A	3
10	D	3-	40	L	3
11	E	4	41	I	4
12	I	4	42	G	8
13	H	3	43	K	8
14	C	8	44	E	6
15	L	3	45	J	3-
16	F	3	46	B	4
17	A	3	47	D	3
18	G	7	48	C	8
19	B	4	49	H	4
20	K	8	50	F	3
21	J	3-	51	A	3
22	E	7	52	I	4
23	D	3	53	L	3
24	H	4	54	G	8
25	C	8	55	K	8
26	L	4	56	E	6
27	F	4	57	B	4
28	A	3	58	J	3-
29	I	4	59	C	8
30	G	8	60	D	3

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet							
Initials:		Observer #: 6					
Date:							
Organization:							
Trial#	Scratch Sample	Rating		Trial#	Scratch Sample	Rating	
1	J	3		31	F	5	
2	E	6		32	D	3	
3	I	5		33	K	8	
4	F	4		34	C	8	
5	B	5		35	G	8	
6	H	4		36	E	7	
7	A	4		37	I	4	
8	C	8		38	L	6	
9	D	3		39	J	5	
10	G	8		40	B	5	
11	K	8		41	A	9	
12	J	3		42	H	4	
13	E	7		43	F	5	
14	I	5		44	K	8	
15	L	6		45	C	8	
16	B	4		46	G	7	
17	H	4		47	D	3	
18	A	4		48	E	7	
19	F	5		49	L	4	
20	C	8		50	J	3	
21	D	3		51	B	6	
22	K	8		52	I	9	
23	G	8		53	A	6	
24	E	7		54	H	1	
25	I	4		55	K	8	
26	J	3		56	C	8	
27	L	4		57	G	8	
28	B	6		58	D	3	
29	A	6		59	F	5	
30	H	4		60	L	9	

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 7			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	J	3	31	B	6
2	I	4	32	K	8
3	F	5	33	G	8
4	H	4	34	L	4
5	A	5	35	D	3
6	K	8	36	C	8
7	E	7	37	I	5
8	D	3	38	H	6
9	B	6	39	J	3
10	G	8	40	E	7
11	L	5	41	F	6
12	C	8	42	A	5
13	J	3	43	B	6
14	I	6	44	K	8
15	H	6	45	L	3
16	F	6	46	G	8
17	A	4	47	C	8
18	E	6	48	D	3
19	D	3	49	I	6
20	B	5	50	H	6
21	K	8	51	J	3
22	G	8	52	F	6
23	L	3	53	E	6
24	C	8	54	B	5
25	I	5	55	K	8
26	H	6	56	L	3
27	F	5	57	G	8
28	J	3	58	C	8
29	E	6	59	D	3
30	A	5	60	A	5

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 8			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	F	5	31	K	8
2	G	8	32	I	4
3	J	3	33	A	5
4	C	8	34	H	4
5	B	6	35	E	6
6	D	4	36	D	4
7	K	8	37	G	8
8	L	4	38	J	3
9	I	4	39	B	6
10	E	6	40	F	5
11	A	5	41	C	8
12	H	4	42	K	8
13	G	8	43	I	4
14	J	3	44	L	4
15	C	8	45	A	5
16	B	6	46	H	4
17	F	5	47	E	6
18	K	8	48	D	4
19	L	4	49	J	3
20	I	4	50	B	6
21	E	6	51	F	5
22	A	5	52	C	8
23	H	4	53	G	8
24	G	8	54	K	8
25	D	4	55	I	4
26	C	8	56	L	4
27	J	3	57	A	5
28	B	6	58	H	4
29	F	5	59	D	4
30	L	4	60	E	6

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 9			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	G	8	31	C	8
2	J	3	32	B	5
3	F	5	33	E	7
4	L	4	34	I	5
5	H	4	35	K	8
6	A	5	36	D	4
7	K	8	37	J	3
8	B	5	38	G	8
9	C	8	39	L	5
10	E	7	40	H	4
11	I	5	41	F	5
12	D	4	42	C	8
13	J	3	43	A	5
14	G	8	44	B	5
15	L	4	45	I	5
16	F	5	46	K	8
17	H	4	47	E	7
18	A	5	48	D	4
19	B	5	49	G	8
20	C	8	50	L	5
21	E	7	51	H	4
22	I	5	52	J	3
23	D	4	53	F	5
24	K	8	54	A	5
25	J	3	55	B	5
26	G	8	56	I	5
27	L	4	57	C	8
28	H	4	58	K	8
29	A	5	59	E	7
30	F	5	60	D	4

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet									
Initials:		Observer #: 10							
Date:									
Organization:									
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating				
1	A	5	31	B	6				
2	F	6	32	H	5				
3	D	4	33	J	3				
4	C	8	34	G	8				
5	B	5	35	E	6				
6	L	4	36	D	4				
7	I	5	37	A	5				
8	H	5	38	K	7				
9	J	3	39	F	6				
10	G	8	40	C	8				
11	K	7	41	I	5				
12	A	5	42	B	6				
13	E	6	43	L	4				
14	D	4	44	J	3				
15	C	8	45	G	8				
16	B	5	46	E	7				
17	F	6	47	H	5				
18	L	4	48	A	5				
19	I	5	49	K	7				
20	J	3	50	D	4				
21	H	5	51	C	8				
22	G	8	52	I	6				
23	A	5	53	F	7				
24	E	7	54	B	6				
25	D	3	55	J	3				
26	C	8	56	G	8				
27	K	7	57	L	5				
28	F	6	58	H	4				
29	L	5	59	E	7				
30	I	5	60	K	7				

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:			Observer #: 11		
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	A	4	31	L	4
2	H	5	32	K	6
3	E	7	33	C	8
4	G	8	34	D	3
5	J	3	35	F	5
6	L	5	36	H	4
7	B	5	37	I	4
8	D	3	38	A	4
9	C	8	39	G	8
10	K	8	40	B	5
11	F	4	41	J	3
12	I	4	42	E	7
13	A	4	43	L	5
14	H	4	44	K	8
15	G	8	45	D	3
16	J	3	46	C	8
17	E	7	47	F	6
18	B	4	48	I	4
19	L	4	49	H	4
20	C	8	50	A	4
21	K	8	51	B	5
22	F	5	52	G	8
23	D	3	53	J	3
24	I	4	54	L	4
25	H	4	55	K	8
26	G	6	56	D	3
27	A	4	57	E	7
28	E	6	58	F	5
29	B	4	59	C	8
30	J	3	60	I	4

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 12			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	J	4	31	H	4
2	A	5	32	C	8
3	C	8	33	E	6
4	I	5	34	K	8
5	F	6	35	D	3
6	L	5	36	B	4
7	G	7	37	J	3
8	E	6	38	A	5
9	H	4	39	L	6
10	B	4	40	F	5
11	D	3	41	G	8
12	K	8	42	I	4
13	J	3	43	H	4
14	A	5	44	E	7
15	C	8	45	K	8
16	F	7	46	D	3
17	L	4	47	B	4
18	I	4	48	C	8
19	G	8	49	A	5
20	H	4	50	J	3
21	E	6	51	F	5
22	D	3	52	G	8
23	K	8	53	I	5
24	B	4	54	H	4
25	A	5	55	E	7
26	J	3	56	K	8
27	F	6	57	L	5
28	L	5	58	D	3
29	I	4	59	C	8
30	G	8	60	B	4

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 13			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	C	8	31	H	4
2	E	6	32	J	3
3	K	7	33	K	8
4	B	4	34	A	4
5	G	8	35	L	4
6	D	3	36	E	6
7	F	6	37	I	4
8	H	4	38	B	4
9	J	3	39	C	8
10	I	4	40	D	3
11	L	4	41	F	6
12	A	4	42	G	8
13	C	8	43	H	4
14	E	6	44	K	8
15	K	8	45	A	4
16	B	4	46	J	3
17	D	3	47	L	4
18	F	6	48	I	4
19	G	8	49	E	6
20	H	4	50	B	4
21	J	3	51	C	8
22	I	4	52	F	6
23	A	4	53	D	3
24	L	4	54	H	4
25	E	6	55	G	8
26	C	8	56	K	8
27	B	4	57	J	3
28	D	3	58	A	4
29	F	6	59	I	4
30	G	8	60	L	4

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 14			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	I	4	31	F	6
2	C	8	32	E	5
3	J	3	33	B	4
4	E	6	34	G	8
5	D	4	35	H	4
6	K	8	36	I	4
7	F	4	37	A	4
8	L	4	38	D	4
9	B	4	39	C	8
10	H	4	40	J	3
11	G	8	41	L	4
12	I	4	42	F	6
13	C	8	43	E	7
14	J	3	44	K	8
15	A	4	45	B	4
16	D	4	46	G	8
17	K	8	47	H	4
18	E	5	48	A	4
19	L	4	49	I	4
20	F	6	50	C	8
21	B	4	51	J	4
22	H	4	52	D	3
23	G	8	53	L	4
24	C	8	54	F	6
25	I	4	55	K	8
26	A	4	56	B	4
27	D	3	57	E	5
28	J	3	58	G	8
29	K	8	59	A	4
30	L	5	60	H	4

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials: _____		Observer #: 15			
Date: _____					
Organization: _____					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	A	4	31	F	6
2	I	5	32	L	4
3	E	7	33	G	8
4	D	4	34	B	5
5	L	4	35	A	4
6	K	8	36	H	4
7	J	3	37	C	8
8	B	5	38	I	5
9	F	6	39	E	6
10	H	4	40	D	4
11	G	8	41	J	3
12	A	4	42	F	6
13	I	6	43	K	8
14	E	7	44	G	8
15	C	8	45	B	5
16	D	4	46	L	4
17	K	8	47	A	4
18	L	4	48	C	8
19	J	3	49	H	4
20	F	6	50	I	4
21	H	4	51	E	7
22	G	8	52	J	3
23	B	4	53	D	4
24	A	5	54	K	8
25	I	4	55	G	8
26	C	8	56	F	4
27	D	4	57	B	5
28	E	6	58	L	4
29	K	8	59	C	8
30	J	3	60	H	4

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:			Observer #: 16		
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	J	3	31	L	4
2	F	6	32	A	5
3	B	4	33	H	4
4	K	7	34	G	8
5	D	3	35	I	4
6	L	3	36	C	8
7	I	5	37	J	3
8	E	7	38	B	4
9	A	3	39	F	6
10	C	8	40	K	8
11	H	4	41	E	7
12	G	7	42	L	4
13	J	3	43	D	3
14	B	4	44	A	4
15	K	8	45	G	7
16	F	4	46	I	5
17	D	3	47	C	8
18	L	4	48	H	4
19	E	7	49	B	4
20	I	5	50	F	6
21	A	3	51	J	3
22	H	4	52	K	7
23	G	7	53	E	6
24	C	8	54	D	3
25	J	3	55	A	5
26	B	4	56	G	7
27	F	6	57	L	4
28	K	8	58	I	5
29	D	3	59	H	4
30	E	7	60	C	8

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet								
Initials:			Observer #: 17					
Date:								
Organization:								
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating			
1	C	8	31	E	7			
2	I	5	32	K	8			
3	G	7	33	F	5			
4	L	4	34	H	4			
5	D	3	35	J	3			
6	B	5	36	A	4			
7	E	5	37	I	5			
8	K	8	38	C	8			
9	H	4	39	G	8			
10	F	5	40	B	4			
11	J	3	41	L	4			
12	A	4	42	D	3			
13	I	5	43	K	8			
14	G	8	44	F	5			
15	L	4	45	H	4			
16	C	8	46	E	5			
17	D	3	47	A	4			
18	B	4	48	I	5			
19	E	5	49	J	3			
20	H	4	50	G	8			
21	K	8	51	C	8			
22	F	4	52	B	5			
23	J	3	53	L	4			
24	I	5	54	D	3			
25	A	4	55	F	4			
26	G	8	56	H	4			
27	C	8	57	E	5			
28	L	4	58	K	8			
29	B	5	59	A	4			
30	D	3	60	J	3			

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 18			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	K	8	31	D	3
2	F	4	32	E	7
3	A	4	33	G	7
4	H	4	34	C	8
5	L	4	35	K	8
6	J	3	36	I	6
7	C	8	37	A	4
8	D	3	38	B	6
9	E	7	39	F	7
10	B	6	40	L	4
11	G	8	41	H	4
12	I	6	42	D	3
13	K	8	43	J	3
14	F	6	44	E	7
15	A	6	45	G	7
16	L	4	46	C	8
17	J	3	47	I	6
18	H	4	48	A	4
19	D	3	49	B	6
20	C	8	50	F	6
21	E	7	51	K	8
22	G	7	52	L	4
23	I	7	53	D	3
24	K	8	54	J	3
25	B	6	55	H	4
26	A	4	56	E	7
27	F	6	57	G	7
28	L	4	58	I	7
29	H	4	59	C	8
30	J	3	60	B	6

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:			Observer #: 19		
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	L	5-	31	A	5-
2	G	8	32	I	6
3	F	6	33	C	8
4	K	8	34	J	3
5	D	3	35	H	5-
6	A	5-	36	G	8
7	H	5	37	E	7
8	B	5	38	F	7
9	I	4	39	K	8
10	C	8	40	D	3
11	E	7	41	L	5
12	J	3	42	A	5
13	G	8	43	B	5
14	F	6	44	C	8
15	K	8	45	J	3
16	D	3	46	H	5
17	L	5	47	I	6
18	H	5	48	E	7
19	B	5	49	F	7
20	A	6	50	G	8
21	I	6	51	D	3
22	C	8	52	L	5
23	J	3	53	A	5-
24	G	8	54	B	5
25	E	7	55	C	8
26	K	8	56	K	8
27	F	7	57	J	3
28	D	3	58	H	5-
29	L	5	59	I	6
30	B	6	60	E	7

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 20			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	A	4	31	G	8
2	B	5	32	I	5
3	F	6, 4	33	C	8+
4	E	6	34	D	3
5	L	4	35	J	3
6	K	7 - 8	36	H	4
7	D	3	37	B	5
8	G	8+	38	E	6
9	I	5	39	F	6, 4
10	C	8+	40	K	7 - 8
11	H	4	41	L	4
12	J	3	42	G	8
13	A	4	43	I	5
14	B	5	44	C	8+
15	F	6, 4	45	D	3
16	E	6	46	J	3
17	L	4	47	H	4
18	K	7 - 8	48	A	4
19	G	8+	49	E	6
20	I	5	50	B	5
21	D	3	51	K	7 - 8
22	C	8+	52	L	4
23	J	3	53	G	8
24	H	4	54	F	6, 4
25	A	4	55	C	8+
26	B	5	56	D	3
27	E	6	57	J	3
28	F	6, 4	58	H	4
29	K	7 - 8	59	A	4
30	L	4	60	I	5

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 21			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	F	-6	31	A	-5
2	J	-3	32	C	-8
3	L	-4	33	B	-4
4	E	-7	34	H	-4
5	D	-3	35	K	-8
6	C	-8	36	G	-8
7	I	-4	37	F	-4
8	G	-8	38	E	-4
9	A	-4	39	J	-3
10	B	MN -4 -5	40	I	-5
11	H	-4	41	D	-3
12	F	-6	42	A	-5
13	K	-8	43	L	-4
14	J	-3	44	B	-6
15	E	-7	45	H	-4
16	D	-3	46	C	-8
17	L	-5	47	G	-8
18	I	-5	48	K	-8
19	G	-8	49	E	-4
20	A	M A 5	50	J	-3
21	C	-8	51	F	-4
22	B	-5	52	I	-5
23	H	-4	53	D	-3
24	K	-8	54	L	-4
25	F	-6	55	B	-6
26	E	-7	56	H	-4
27	J	-3	57	C	-8
28	D	-3	58	A	-5
29	I	-5	59	G	-8
30	L	-4	60	K	-8

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials: _____			Observer #: 22		
Date: _____			Organization: _____		
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	A	4	31	I	4
2	L	4	32	H	4
3	K	8	33	F	5
4	B	4	34	G	8
5	D	3	35	C	8
6	J	5	36	E	6
7	I	4	37	A	4
8	F	6	38	B	4
9	G	6	39	J	3
10	H	3	40	K	8
11	C	8	41	L	4
12	A	4	42	I	4
13	L	4	43	H	4
14	E	7	44	D	3
15	K	8	45	G	8
16	B	4	46	C	8
17	J	3	47	F	6
18	D	3	48	E	6
19	F	6	49	A	4
20	I	4	50	B	4
21	H	4	51	K	8
22	G	8	52	J	3
23	A	4	53	L	4
24	C	8	54	I	4
25	E	7	55	D	3
26	L	3	56	H	4
27	B	4	57	G	8
28	J	3	58	C	8
29	K	8	59	F	6
30	D	3	60	E	6

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 23			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	G	F428-8	31	L	-4
2	E	F428-7	32	A	-4
3	K	F428-8	33	C	-8
4	J	F428-3	34	F	-4
5	A	F428-4	35	I	-5
6	H	F428-4	36	K	-8
7	B	F428-5	37	D	-3
8	C	F428-8	38	E	-7
9	L	F428-4	39	H	-4
10	D	F428-3	40	J	-3
11	I	F428-6	41	G	-8
12	F	F428-6	42	L	-4
13	E	F428-7	43	A	-4
14	K	F428-8	44	C	-8
15	J	F428-3	45	F	-4
16	A	F428-4	46	I	-5
17	H	F428-4	47	K	-8
18	G	-8	48	D	-3
19	B	-4	49	B	-5
20	L	-4	50	E	-7
21	C	-8	51	J	-3
22	D	-3	52	H	-4
23	F	-4	53	G	-8
24	I	-5	54	A	-4
25	K	-8	55	C	-8
26	J	-3	56	L	-4
27	E	-7	57	F	-4
28	H	-6	58	I	-5
29	G	-8	59	D	-3
30	B	-5	60	B	-5

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:	Observer #: 24				
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#		
1	C	8	31	J	3
2	F	6	32	I	4
3	G	7	33	L	4
4	A	4	34	D	3
5	J	3	35	K	7
6	H	4	36	F	7
7	B	4	37	C	8
8	I	5	38	E	5
9	L	4	39	A	4
10	D	3	40	G	7
11	K	7	41	B	4
12	C	8	42	J	3
13	F	7	43	H	4
14	G	7	44	I	5
15	A	4	45	L	4
16	E	5	46	D	3
17	H	4	47	F	6
18	B	4	48	K	7
19	J	3	49	E	5
20	I	4	50	A	4
21	D	3	51	C	8
22	L	4	52	G	7
23	K	7	53	J	3
24	F	7	54	H	4
25	C	8	55	B	4
26	A	4	56	L	4
27	E	5	57	I	4
28	H	4	58	D	3
29	G	7	59	K	7
30	B	4	60	E	5

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials: _____			Observer #: 25		
Date: _____			Organization: _____		
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	D	F428-3	31	G	F428-7
2	C	F428-8	32	I	F428-4
3	J	F428-3	33	A	F428-4
4	B	F428-4	34	F	F428-4
5	E	F428-5	35	L	F428-5
6	K	F428-7	36	C	F428-8
7	G	F428-7	37	H	F428-6
8	L	F428-5	38	D	F428-3
9	I	F428-4	39	E	F428-5
10	A	F428-4	40	J	F428-3
11	F	F428-6	41	K	F428-7
12	H	F428-6	42	B	F428-4
13	C	F428-8	43	G	F428-7
14	D	F428-3	44	A	F428-4
15	B	F428-4	45	F	F428-6
16	J	F428-3	46	L	F428-5
17	E	F428-5	47	C	F428-8
18	K	F428-7	48	H	F428-6
19	G	F428-7	49	I	F428-4
20	I	F428-4	50	E	F428-5
21	L	F428-5	51	D	F428-3
22	A	F428-4	52	K	F428-7
23	F	F428-6	53	B	F428-4
24	C	F428-8	54	G	F428-7
25	D	F428-3	55	J	F428-3
26	H	F428-6	56	A	F428-4
27	J	F428-3	57	F	F428-6
28	E	F428-5	58	L	F428-5
29	K	F428-7	59	H	F428-6
30	B	F428-4	60	I	F428-4

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 26			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	L	5 4	31	H	4
2	F	7 6	32	A	4
3	D	4 3	33	B	5
4	G	8 7	34	L	4
5	C	8	35	J	3
6	K	8	36	I	4
7	H	4	37	E	7
8	A	4	38	G	7
9	I	4 5	39	K	8
10	B	5	40	D	3
11	J	3	41	C	7 8
12	L	4	42	F	6
13	E	8	43	A	4
14	D	3	44	H	4
15	G	7	45	B	5
16	C	8	46	L	4
17	K	8	47	I	4
18	F	6	48	E	7
19	H	4	49	J	3
20	A	4	50	K	8
21	B	5	51	G	7
22	J	3	52	D	3
23	L	8 4	53	C	8
24	I	4	54	A	4
25	E	7	55	H	3
26	G	7	56	B	4
27	C	8	57	F	5
28	K	8	58	I	4
29	D	3	59	E	7
30	F	6	60	J	3

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet						
Initials: _____			Observer #: 27			
Date: _____			Organization: _____			
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating	
1	A	4	31	A	4	
2	D	3	32	E	7	
3	C	8	33	J	3	
4	G	7	34	F	6	
5	L	4	35	H	5	
6	K	8	36	I	4	
7	B	5	37	C	8	
8	E	6	38	L	4	
9	F	4	39	G	7	
10	J	3	40	K	8	
11	H	5	41	B	5	
12	I	4	42	D	3	
13	D	3	43	E	6	
14	C	8	44	A	4	
15	G	7	45	F	6	
16	L	4	46	H	5	
17	K	8	47	I	4	
18	B	5	48	J	3	
19	A	4	49	C	8	
20	F	6	50	L	4	
21	E	7	51	G	7	
22	J	3	52	B	5	
23	H	5	53	D	3	
24	I	5	54	E	7	
25	C	8	55	K	8	
26	D	3	56	A	4	
27	L	4	57	H	5	
28	G	7	58	F	6	
29	K	8	59	I	4	
30	B	5	60	J	3	

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials: _____		Observer #: 28			
Date: _____		Organization: _____			
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	E	7	31	L	4
2	D	3	32	F	6
3	H	4	33	B	5
4	A	5	34	J	3
5	L	4	35	C	8
6	I	6	36	D	3
7	K	8	37	G	8
8	G	8	38	H	4
9	C	8	39	A	4
10	F	6	40	E	7
11	B	5	41	I	4
12	J	3	42	L	4
13	D	3	43	K	8
14	E	7	44	F	5
15	H	4	45	B	4
16	A	4	46	C	8
17	L	4	47	J	3
18	I	6	48	G	8
19	K	8	49	H	4
20	C	8	50	A	4
21	F	6	51	E	7
22	B	5	52	I	4
23	J	3	53	L	4
24	G	8	54	K	8
25	D	3	55	D	3
26	E	7	56	B	4
27	H	4	57	C	8
28	A	4	58	J	3
29	I	6	59	G	8
30	K	8	60	F	7

APPENDIX A (continued)

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: 29			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	D	4	31	F	7
2	E	7	32	A	4
3	K	8	33	H	3
4	C	8+	34	L	4
5	I	5	35	G	8
6	B	5	36	J	1
7	A	4	37	K	8
8	F	7	38	D	4
9	J	1	39	I	5
10	H	3	40	E	7
11	L	4	41	C	8+
12	G	8	42	B	5
13	D	4	43	A	4
14	E	7	44	H	3
15	K	8	45	F	7
16	I	5	46	L	4
17	B	5	47	G	8
18	A	4	48	J	1
19	C	8+	49	D	4
20	F	7	50	I	5
21	H	3	51	E	7
22	L	4	52	C	8+
23	G	8	53	B	5
24	J	1	54	K	8
25	D	4	55	A	4
26	K	8	56	H	3
27	I	5	57	L	4
28	E	7	58	F	7
29	B	5	59	J	1
30	C	8+	60	G	8

APPENDIX A (continued)

#30

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: S/S - A			
Date:					
Organization:					
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	L	-4	31	A	-4
2	G	-8	32	I	-4
3	F	-6	33	C	-8
4	K	-8	34	J	-3
5	D	-3	35	H	-4
6	A	-4	36	G	-8
7	H	-4	37	E	-6
8	B	-7	38	F	-7
9	I	-5	39	K	-8
10	C	-8	40	D	-3
11	E	-6	41	L	-4
12	J	-3	42	A	-4
13	G	-8	43	B	-4
14	F	-6	44	C	-8
15	K	-8	45	J	-3
16	D	-4	46	H	-4
17	L	-4	47	I	-4
18	H	-4	48	E	-7
19	B	-4	49	F	-6
20	A	-3	50	G	-8
21	I	-4	51	D	-3
22	C	-8	52	L	-4
23	J	-3	53	A	-4
24	G	-8	54	B	-4
25	E	-6	55	C	-8
26	K	-8	56	K	-8
27	F	-6	57	J	-3
28	D	-7	58	H	-4
29	L	-4	59	I	-4
30	B	-4	60	E	-6

APPENDIX A (continued)

#31

ASTM Intensity of Scratches Interlaboratory Study Data Sheet					
Initials:		Observer #: S/S - R			
Date:	Organization:				
Trial#	Scratch Sample	Rating	Trial#	Scratch Sample	Rating
1	L	-4	31	A	-4
2	G	-8	32	I	-4
3	F	-6	33	C	-8
4	K	-7	34	J	-3
5	D	Less -3	35	H	-9
6	A	-4	36	G	-8
7	H	-4	37	E	-6
8	B	-5	38	F	-6
9	I	-4	39	K	-7
10	C	-8	40	D	-3
11	E	-6	41	L	-4
12	J	-4	42	A	-4
13	G	-8	43	B	-5
14	F	-6	44	C	-8
15	K	-7	45	J	-3
16	D	Less -3	46	H	-4
17	L	-4	47	I	-4
18	H	-4	48	E	-6
19	B	-5	49	F	-6
20	A	-4	50	G	-8
21	I	-4	51	D	-3
22	C	-8	52	L	-4
23	J	-3	53	A	-4
24	G	-8	54	B	-5
25	E	-6	55	C	-8
26	K	-7	56	K	-7
27	F	-6	57	J	-3
28	D	-3	58	H	-4
29	L	-4	59	I	-5
30	B	-5	60	E	-6

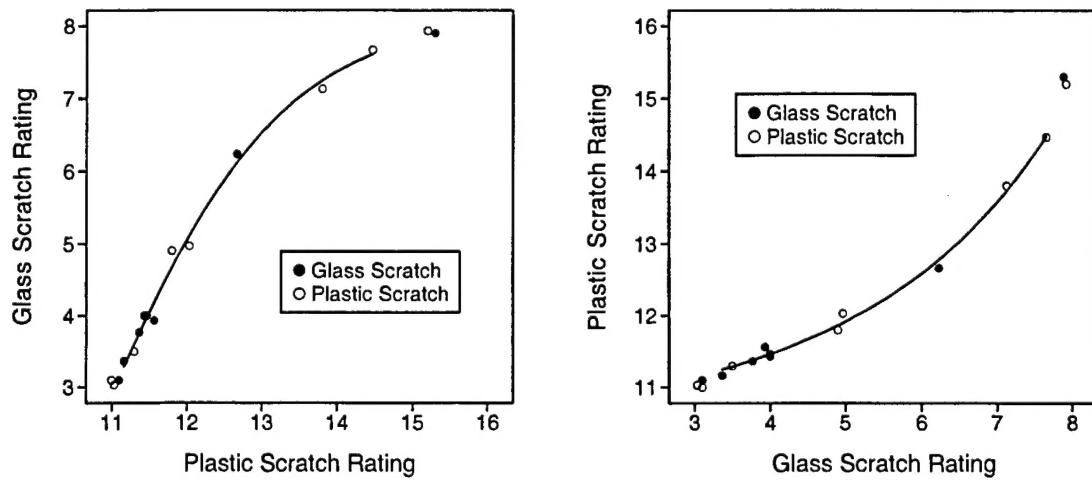
APPENDIX B

Comparison of Glass and Plastic Scratch Ratings (non-mandatory information):

A study was performed to determine equivalent relationships between glass and plastic scratch adjuncts. This empirically derived relationship can be used if needed when: (1) only glass adjuncts are available to judge the intensity of scratches in plastic, (2) only plastic adjuncts are available to judge the intensity of scratches in glass or (3) it is desirable to convert the between the glass and plastic scales.

Five trained observers rated eight glass and eight plastic scratches. Each scratch was rated using both glass and plastic adjuncts three times. The 96 trials for each observer were randomized with the constraint that there be at least five trials between replications of the same scratch and either glass or plastic adjunct. Figure 3 shows the number of trials for each observer and scratch having a particular scratch rating.

Figure 1 contains the estimated relationship between the glass (G) and plastic (P) scratch ratings and between the plastic and glass ratings. Table 1 and Figure 2 contain the mean scratch rating for each scratch.



$$G = 8.06 \left(1 - e^{-\left(\frac{P - 9.48}{2.54} \right)^{1.57}} \right)$$

$$P = 9.76 + e^{\left(\frac{G}{5.86} \right)^{1.64}}$$

Figure 1. Non-linear regression fit of mean scratch ratings (N = 15). The 3 means near (P = 11, G = 3) and the 2 means near (P = 15, G = 8) were not used since they contained multiple trials where the glass rating was either 3- or 8+.

Table 1. Mean glass and plastic scratch rating for each scratch (N = 15).
Ratings are sorted by glass adjunct.

Scratch Material	Scratch	Mean Rating (N = 15)	
		Glass Adjunct	Plastic Adjunct
Glass	D	3.1	11.1
	A	3.4	11.2
	I	3.8	11.4
	L	3.9	11.6
	B	4.0	11.5
	F	4.0	11.4
	E	6.2	12.7
	G	7.9	15.3
Plastic	O	3.0	11.0
	I	3.1	11.0
	C	3.5	11.3
	A	4.9	11.8
	L	5.0	12.0
	B	7.1	13.8
	F	7.7	14.5
	G	7.9	15.2

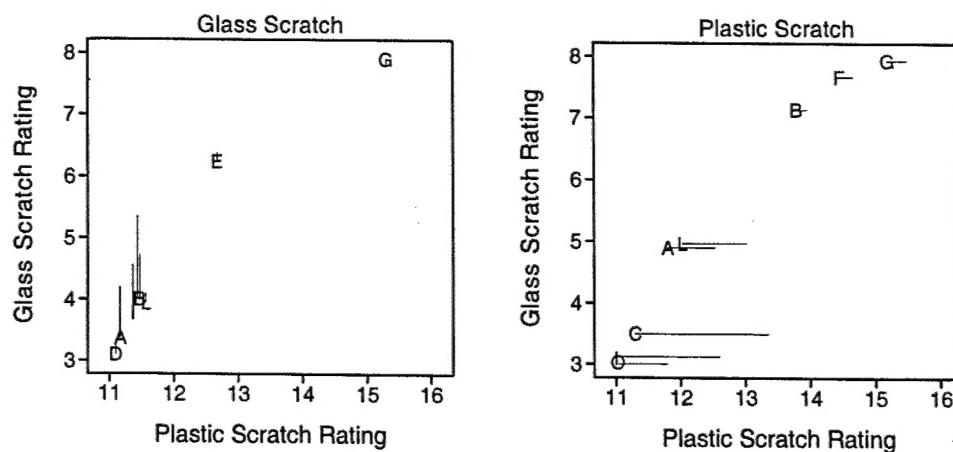


Figure 2. Mean glass and plastic scratch rating for each scratch (N = 15).
Solid line segments connect means in this study with means from previous studies involving glass or plastic only.

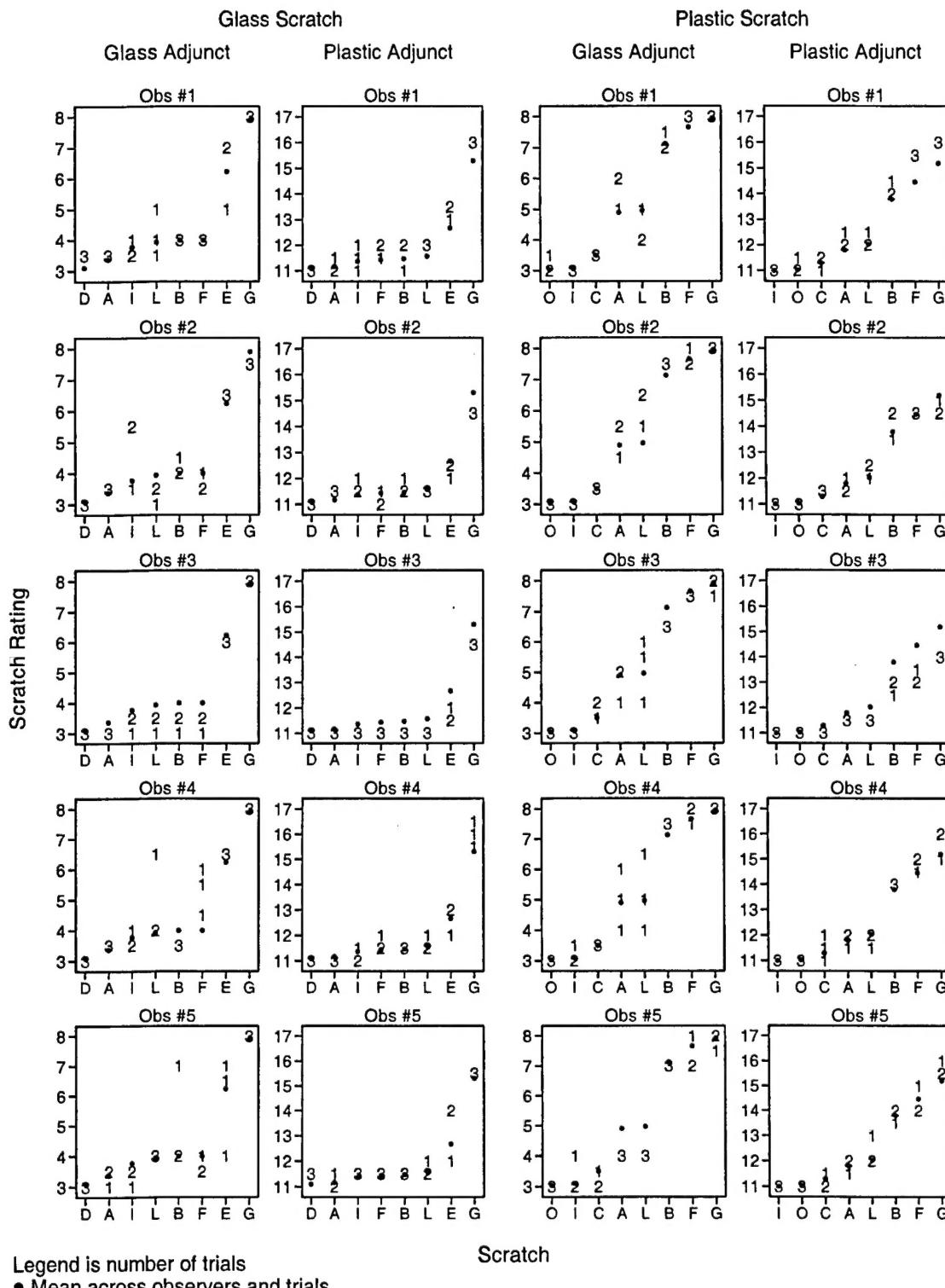


Figure 3. Number of trials for each observer and scratch (N = 3) having a particular scratch rating when compared with either glass or plastic adjunct.